Geophysical Research Abstracts
Vol. 21, EGU2019-11561, 2019
EGU General Assembly 2019

The life story of a natural arch

Jaroslav Řihošek (1), Martin Slavík (1), Jiri Bruthans (1), and Michal Filippi (2)

(1) Charles University in Prague, Institute of Hydrogeology, Engineering Geology and Applied Geophysics, Praha 2, Czech Republic, (2) Institute of Geology of the Czech Academy of Sciences, Rozvojová 269, 165 00 Prague 6, Czech Republic

Weathering and erosion of sandstone across the world can produce various sandstone landforms such as arches, alcoves, pedestal rocks, pillars etc. Probably the most striking features of sandstone landscapes are arched natural rock formations known as natural bridges or more generally natural arches. Natural arches can in some cases exhibit extremely elongated slender arched lintels spanning tens of meters. Origin and evolution of such perfectly-developed arches remain unclear when various authors emphasize different factors to be essential.
Using artificial water erosion applied on specific friable sandstone, we were able to simulate development of small-scale arches in situ representing arc natural arch and protruding arch. Initial input shape imitated natural sandstone fin with horizontal/inclined discontinuity. Erosion removed the material from a stress shadows along the discontinuity creating an arch opening. Furthermore the erosion exposed a compressed zone above the discontinuity sculpting a thin lintel spanning over the discontinuity.
Based on 3D photogrammetric analyses of arch development and numerical modeling of mechanical stress distribution in the small-scale arch we established three evolutional stages of the modelled arch – the initial, mature and senile stage.
Evolution of the modelled arch clearly showed that a thin elongated rock protrusion (fin) consisting of stress-controlled sandstone and appropriate discontinuity are the only essential conditions for erosion-driven development of an arch, regardless of the kind of prevailing erosional process.
3D photogrammetry and numerical modelling of stress distribution help not only to understand evolution of natural arches and other stress-controlled landforms but also can have much broader application in understanding processes of landscape evolution in the field of geomorphology.
The research was funded by the Czech Science Foundation (GA CR No. 19-14082S).